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THE REVIEW OF ECONOMIC STATISTICS

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INDICES OF BUSINESS CONDITIONS

I. A STUDY OF STATISTICAL METHOD

I. GENERAL CONSIDERATIONS AND ASSUMPTIONS

ANYONE who examines the current financial, commercial, and trade papers will be impressed with the large amount of space given to statistical data of various kinds. Perhaps the most important service rendered by such journals as the *Commercial and Financial Chronicle*, *Bradstreet's*, the *Iron Age*, and the *New York Journal of Commerce* is to collect and publish regularly statistical series with weekly or monthly items. Some of the data are of interest only to special trades or industries but a very large part have a wider interest and significance since they furnish indices of general business conditions. Thus the *Commercial and Financial Chronicle* specializes in bank clearings and railway gross and net earnings, in addition to statistics of interest rates, stock and bond prices, and finance in general; *Bradstreet's* specializes in statistics of failures, value of building permits, and commodity prices; the *Iron Age* in statistics of iron and steel production and prices of iron, steel, lead, copper, and zinc; and the *New York Journal of Commerce* in new security issues, total dividends paid, and new corporations launched. In some cases the scope and method of collection of the data are revealed; in most cases little or no information is published. The data collected by these and other journals are widely copied.

As is implied by the illustrations just given, the great mass of data indicative of business conditions is collected by privately owned periodicals. Despite the fact that current business and industrial statistics are probably more widely used than any other statistical data, the government has given little attention to their collection or compilation. The statistical series collected and published by the government are few in number and limited in scope and variety. The narrowness of their range is indicated by an enumeration of the more important fields which they cover: foreign trade statistics (*Monthly Summary of Foreign Commerce*), the

number of immigrants (*Bulletin of the Bureau of Immigration*), index numbers of prices (*Bulletin of the Bureau of Labor Statistics*), and the reports of the Federal Reserve Banks (*Federal Reserve Bulletin*). It should be said, however, that the Federal Reserve Board has recently (by the publication of price indices) inaugurated a plan of publishing various series of business statistics in the *Federal Reserve Bulletin*.¹ In general, however, notwithstanding this recent commendable expansion of effort, it is still true that the statistical service supplied by the government is limited in quantity and variety as compared with the service furnished by the private publications. Moreover, the government statistics have usually had a further defect: they have failed to meet the business requirement of promptness. The index number of prices of the Bureau of Labor Statistics, for example, has lost much of its serviceability by reason of the fact that it has usually appeared several months late.

The variety, scope, and promptness of the data presented, however, whether by the private journals or by the government, are not the only features of an adequate service of statistics of business conditions. Still more important are the quality of the data, the extent to which they are subjected to analysis, and the soundness and adequacy of the methods employed in such analysis. So far as analysis is concerned, none of the journals which collect and publish fundamental statistics apply any except the simplest and most obvious methods of analyzing the data presented. The usual method is to compare the figure for the current week or month with that for the corresponding week or month of the preceding year, or that for the preceding week or month of the same year. Sometimes these comparisons are improved by giving them in percentage figures. Thus *Bradstreet's* states the percentage change in the value of building permits for the current month as compared with the corresponding month of the previous year. Similarly, the *Commercial and Financial Chronicle* gives percentages for weekly bank clearings and

¹ See *Federal Reserve Bulletin*, July, 1918, et seq.

monthly gross earnings of railways. Aside from such simple comparative statements as these, no statistical analysis of the data is attempted, although the data are frequently accompanied by valuable editorial comment.

Not only are the methods of analysis adopted elementary, but the quality of the data published is probably very uneven. Errors and discrepancies are not infrequent. Sometimes they appear in the form of a disagreement of supposedly identical figures given in different numbers of the same journal, or of important inconsistencies in figures taken from the same table. Errors of this sort are, of course, sometimes due to misprints, which no care in publication can wholly eliminate. Sometimes seeming inconsistencies are occasioned by the fact that preliminary figures are later subjected to decided revision. This practice of revision, commendable and often necessary, is followed by all journals. But whatever their cause, the fact that significant discrepancies of various types do occur indicates the need of careful examination of the data before they are utilized.¹

Sometimes discrepancies arise from the fact that different figures for a given subject are published by different journals. Thus the *Chronicle*, *Dun's Review*, and *Bradstreet's* give figures for the par value of bonds traded on the New York Stock Exchange which commonly differ by one or two per cent and occasionally differ more strikingly.² Again, when two or more agencies investigate independently the same general subject (e. g., *Dun's* number of "commercial failures" and *Bradstreet's* number of "business failures") there is need of careful examination of the series, to see whether they are consistent or whether they provide the basis of divergent conclusions.

Furthermore, quite aside from errors and discrepancies due to misprints, revision of figures, difficulties in collection, lack of continuity in system, attention should be given to the degree of fullness and accuracy with which the data collected and published, even though they be in themselves accurate, describe the field to which they pertain. Commonly the data presented are, of necessity, samples. The preliminary figures for gross earnings of railroads, which the *Chronicle* publishes in its issue near the 15th of each month, must be based upon available reports for the month previous. Such reports have sometimes covered as few as nineteen roads.³ Later this journal publishes final figures for some two hundred roads. Bank clearings, as pub-

lished by *Bradstreet's*, are for a selected group of cities. The figures for value of building permits collected by Babson's Statistical Organization are for twenty cities, selected from *Bradstreet's* list of one hundred and forty or more cities. There is need, therefore, for careful consideration of the adequacy and accuracy with which the samples presented represent conditions.

Finally, it is to be noted that the figures published by statistical agencies may not be what they appear to be, by reason of the fact that the time period covered by the figures does not always correspond with the time period stated. A case in point is the monthly figures for exports from the United States in the last months of 1917. The figures for "December" of that year in reality cover a period of six weeks. The explanation of the fact is that a reorganized statistical department of the customs service was bringing the compilations up to date.⁴ Errors of this sort, amounting to 25 per cent or more, are doubtless infrequent. Yet there is often some smaller, but still significant, degree of discrepancy in the data arising from a difference in the time units employed. For example, a month may not always mean the calendar month for all statistical series published. Sometimes a "statistical month" is used as the basis of the figures — a month closing on a fixed day. An item for "February," for instance, may be a total for the thirty-one days ending February 25th, or on some other fixed date. This device of a statistical month is sometimes a practical necessity for convenience in handling the data.

The various considerations that have been presented are perhaps sufficient to indicate the more important characteristics, and the significant defects, now commonly to be found in business statistics. It is not the purpose of this study to make out an exhaustive case of errors and deficiencies, but merely to suggest their general character. Nor is there any intention of criticizing the commercial journals and agencies ungenerously, or to under-rate the importance of the service which they render. The studies appearing in this REVIEW will be based largely upon data published by them, and we point out the defects, as well as the merits, of their work in order to offer some general suggestions as to how it may be improved. The REVIEW recognizes that the difficulties attendant upon the collection of accurate and significant statistics of business conditions are very great.

It is with the hope that profitable coöperation may ensue, therefore, rather than in a spirit of criticism that

taken much of our data from them because of their reliability and high standing. The *Chronicle*, in particular, we have used most freely.

² *Bradstreet's*, 45, p. 711, gave the bond sales for October 1916 as (in round numbers) \$145,000,000, whereas the *Bank and Quotation Supplement of the Commercial and Financial Chronicle* for November 1917, gave the figure as \$134,000,000.

³ This practice was discontinued in September 1918, because of the inadequacy of the data received from the Railroad Administration for the compilation.

⁴ This explanation was given to the writer by J. F. Carroll, Deputy Collector of the port of New York, in charge of the Division of Customs Statistics. In the last six months of 1917 the official values of exports range from \$373,000,000 in July to \$600,000,000 in December. The figure for January 1918 is \$505,000,000.

¹ A detailed list of examples of discrepancies due to misprints or to revision of figures would be unprofitable. One or two errors of a somewhat different sort, however, may be cited. The *Chronicle* in giving monthly bank clearings for New York and "Outside" in the first or second number of each month, has published numerous tables during 1918 with erroneous captions. For instance, the figures for 1918 and 1917 are published under the headings 1917 and 1916, or even 1915 and 1914. A defect of another sort, and a very common one, may be illustrated by the practice of the *New York Journal of Commerce* in publishing figures for "Incorporations in Eastern States" without accompanying the figures with a definition of "Eastern States." One is left in doubt as to what the figures include and whether they always include precisely the same territory. Needless to say, these examples are not indicative in any sense of an adverse judgment on our part of the journals cited. On the contrary, we have

this REVIEW has been established. There is need of a division of function. The collection and publication of data is a task by itself, a task so important, difficult, and expensive as to absorb most of the attention of the commercial and financial papers. A different function is that of analysis of the data; a task to which as yet comparatively little attention has been given. Yet, in view of the considerations that have been presented, and in view of the extensive application of which fundamental statistics are capable, it is clear that in order to bring out their full significance there must be a thorough examination of the data and a development of adequate methods of handling them. This is the work to which the REVIEW OF ECONOMIC STATISTICS hopes to make some contribution.

More specifically, the task which is contemplated may be described as follows:

1. To contrive a method of handling business statistics which will make it easy to determine the significance or lack of significance of each item in indicating current conditions and possibly those of the immediate future.
2. To make a thorough study of the available data. How are they collected? Are the items homogeneous? If samples, are they adequate? What is the probable error? Have the industries or institutions which are the sources of the data held a uniform position in our economic life during the period in question? Are averages of security prices, commodity prices, and other composite indices correctly constructed? In short, are the data reliable material for the application of statistical analysis.
3. To coöperate with agencies now collecting data to the end that defects in such data may be remedied. Likewise to collect new data or compile new series where necessary.
4. To apply statistical analysis to current data in order that "corrected" statistics may be published periodically.

This first number will be devoted to the first-named portion of the task — the development of a method for handling the data. Before proceeding to the detailed explanation it will be conducive to clearness to point out some general criteria in accordance with which the data have been selected and the method constructed, and to outline briefly the successive steps of the exposition which is to follow.

Isolated statistical items have no significance. Only by a comparison of items over a period of time can one sense the meaning. For such comparison we need to have continuous and homogeneous data. As a first step in developing a method of analysis, therefore, it has been necessary to make a selection of those time series which appear, *prima facie*, to be the most reliable and significant among those available. Such series include bank clearings, the value of building permits, gross earnings of railways, commodity prices, number of business failures, pig-iron production, interest rates on commercial paper, the yield of bonds, call rates,

imports, and sales on the New York Stock Exchange.¹ Although the intensive examination and complete analysis of these and other series is postponed for the time being, the importance of such examination is fully appreciated.

It is not assumed that the selection which has here been made of series of fundamental statistics is the best for permanent use, or that each series included is more significant as an index of business conditions than other series which are excluded. Regard has had to be given to the length of time for which the series are obtainable in usable form. The series selected are the best available in the sense that they go back a sufficient number of years (at least to 1903) to be significant for our purpose, and are to be had in a form that does not require too great an amount of computation before they can be utilized. It is admitted that, on other grounds, some of the series included in the list are inferior to certain others which have not been included. Thus, Babson's series of gross earnings of "ten leading roads," which we include in our list, is probably not an adequate sample. The Interstate Commerce Commission publishes complete figures. Those figures, however, extend back only to 1908, whereas the Babson series is, apparently, a homogeneous one covering a period sufficiently long for the purpose of this study. In view of these considerations it needs to be stated clearly that the data taken for the present "background" study constitute a tentative selection, and will not necessarily be used permanently as the best indices of business conditions.

Each item of each series considered is a total or average or relative number applying to a definite period of time. In any given series the items are for months or years. Monthly series beginning with 1903 and annual series beginning with 1879 will be used almost exclusively as the material for experiment. Monthly data previous to 1903 are not readily obtainable for a number of series. The year 1879 is chosen as the starting point for the series of annual data because it is the date of the resumption of specie payments.

The method of investigation followed is experimental. Every statistical procedure under consideration is tested by applying it to statistical series of various types. No method is thought worth while testing that cannot be made entirely objective, that cannot be reproduced exactly by an individual working according to the directions laid down. The primary requirement in the argument is that each step be tested; the primary requirement in the method evolved is that the operations should be fully explained and reproducible.

As has been said, the meaning of fundamental statistics can be sensed only by a comparison over time of fluctuations occurring in continuous and homogeneous series. It is to be expected, however, that in any series fluctuations may occur as the result of the operation of various forces that affect the phenomena observed. These forces may sometimes operate in the same direction and sometimes at cross-purposes; some of them

¹ A list of the series, sources of data, and definitions of items are given on p. 39 *et seq.*

may be more potent and significant than others; and, finally, some may be recurring and regular while others are occasional and accidental. That several kinds of fluctuations appear in any time series is obvious. For example, we expect pig-iron production to be vastly greater in 1910 than in 1890, because of the growth of the industry in the interval. On the other hand, we know from experience that there are periods of prosperity and depression, and are not surprised, notwithstanding the large increase *for the whole period*, to find considerable ups and downs in the production of pig iron *during the period*. Irregular or accidental occurrences, likewise, cause fluctuations — a strike, a court decision, the outbreak of war. Within any given year, also, there are fluctuations. The round of the seasons is known to produce changes in the volume of production or of sales, as well as other related changes. Moreover, *all* of these forces may be at work simultaneously: and all of them play a part in determining the fluctuations which occur in a statistical series. Those fluctuations are thus a confused conglomerate growing out of numerous causes which overlie and obscure one another.

In view of this complexity the simple comparison of items within time series, in what may be termed their crude state, is of but little significance. How ascertain from such a conglomerate the particular meaning of any given change in the figures? How divide the given change into its constituent parts? In other words, how isolate and measure the influence of different sets of forces or forces? These are the difficult problems which render necessary the development of an adequate method for the analysis and comparison of statistics of business conditions.

Stated positively, the problem is to devise a method of unravelling, in so far as may be, the tangle of elements which constitute the fluctuations in fundamental series; that is, of distinguishing and measuring types of changes; of eliminating certain types; and thus of revealing in the corrected data the quantitative effect of those forces which underlie the business and industrial situation. In other words, the problem is to devise a method of analysis whereby the crude time series of business statistics now published in our trade and financial journals may be set forth in such a form as to be significant and reliable indices of business conditions.

It is essential, therefore, that at the outset of this study there should be a clear-cut definition of the assumptions which we have made concerning the nature of the fluctuations found in time series. A preliminary survey of the graphs of such fundamental monthly series as bank clearings, iron production, commodity prices, and new building permits has led to the following working hypothesis, namely that each series is a composite consisting of four types of fluctuations. The four types are:

1. A long-time tendency or secular trend; in many series, such as bank clearings or production of commodities, this may be termed the growth element;

2. A wave-like or cyclical movement superimposed upon the secular trend; these waves appear to reach their crests during periods of industrial prosperity and their troughs during periods of industrial depression, their rise and fall constituting the business cycle;

3. A seasonal movement within the year with a characteristic shape for each series;

4. Residual variations due to developments which affect individual series, or to momentous occurrences, such as wars or national catastrophes, which affect a number of series simultaneously.

Although these four types of fluctuations occur in all series, they are by no means uniform in different series. Each series appears to have a characteristic secular trend for a selected period;¹ each appears to have cycles, but these cycles are neither synchronous nor of the same intensity;² each appears to have a seasonal movement and irregular variations peculiar to itself. In consequence of these individual traits each series must be treated by itself. General methods may, indeed, be developed; but such methods must always take into account the special characteristics of each series.

With this brief preliminary survey, we proceed to the separate consideration of the types of fluctuations.

2. MEASUREMENT OF SECULAR TREND

Current statistical items such as bank clearings, interest rates, prices, and number of business failures convey a meaning only in case we are able to compare such items with others of a similar nature for other periods, or with a standard of some sort. We require a "normal" as a bench mark from which to reckon. For statistical items pertaining to different time intervals this "normal" may not be constant. There may be a normal change year after year in a developing or changing industrial society, just as there is a normal change in the physical or mental status of a growing child. The initial problem to be solved in using statistics as indices of business conditions is the problem, first, of ascertaining if there is a change in the items year after year, second, of determining the normality or regularity of such change, and third, if there be a normal change, of measuring it and correcting the original items for it. This is the problem of the secular trend. Graphically, the problem of secular trend may be thought of as the problem of securing a line or curve, the general direction and position of which are determined by the data.³

Both the existence and the measurement of secular trend are to be established, not on *a priori* grounds, but by examination of the statistics themselves. To be sure, it is sometimes possible to deduce the *direction* of the movement of a given series in advance of special investigation. For instance, the trend of such series as the production of commodities in a growing country

¹ See "The Variate Difference Method and Curve-Fitting," by W. M. Persons, *Quarterly Publications of the American Statistical Association*, June, 1917.

² See "The Construction of a Business Barometer; Annual Data," by W. M. Persons, *American Economic Review*, December, 1916.

³ See Chart 1, *et seq.*